Labs21:
Improving the Performance of Laboratories
Optimizing Air Changes – one of the Big Hits

September 21, 2006 Dale Sartor, P.E.

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What is Labs21?

- **A joint EPA/DOE partnership program to improve the environmental performance of U.S. laboratories including:**
  - Minimize overall environmental impacts
  - Protect occupant safety
  - Optimize whole building efficiency on a lifecycle basis
- **A growing network of 3,500+ laboratory designers, engineers, facility/energy managers, health and safety personnel, and others.**

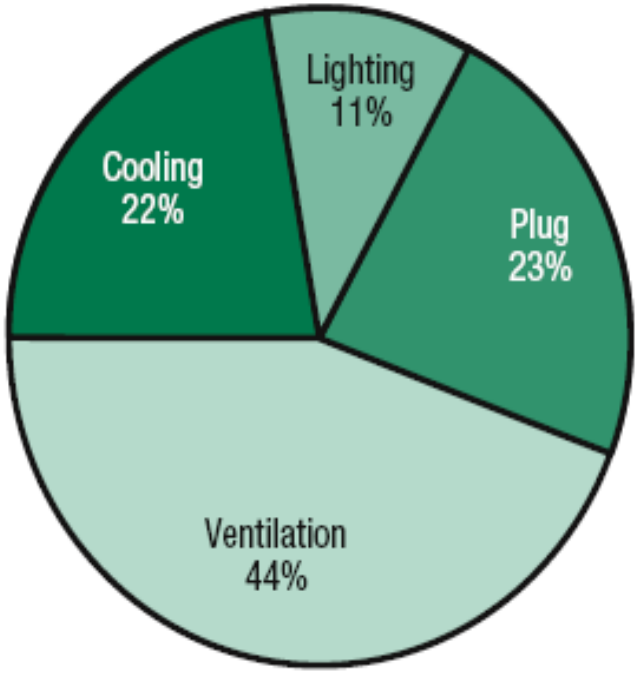
More detail on specific best practices: Five BIG HITS

1. Tame the hoods
2. **Scrutinize the air changes**
3. Drop the pressure drop
4. Get real with plug loads
5. Just say no to re-heat

Ventilation Energy in Laboratories

- Up to 50% of electrical energy use
- Small reductions have large impact
- Affects cost to build and maintain facility

Maximize Effectiveness; Minimize Energy Use



Annual electricity use in Louis Stokes Laboratory, National Institutes of Health , Bethesda, MD

Optimizing Ventilation

Why ventilation?

- Worker Safety
- Space conditioning

What is "optimizing"?

- Air Change Rate
- Air Dilution
- Air Circulation

An optimized laboratory design both safely handles the "worst" emergency and efficiently manages "routine" incidents and normal conditions

Modeling and Simulation

Modeling Methods…

- **Tracer Gas Evaluations**
- **Neutrally-buoyant helium bubble evaluations**
- **Computational Fluid Dynamics (CFD)**

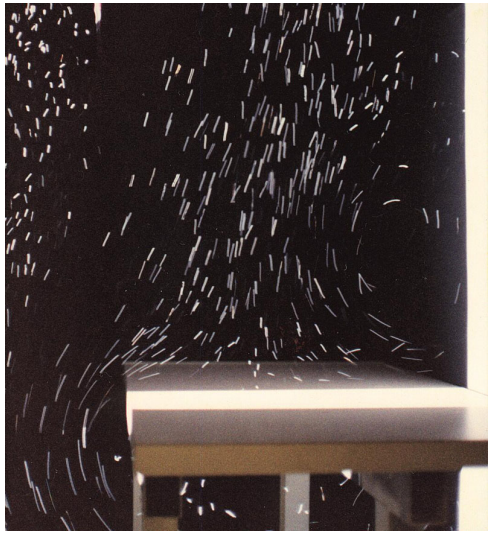
Evaluate…

- **Containment**
- **Ventilation effectiveness**

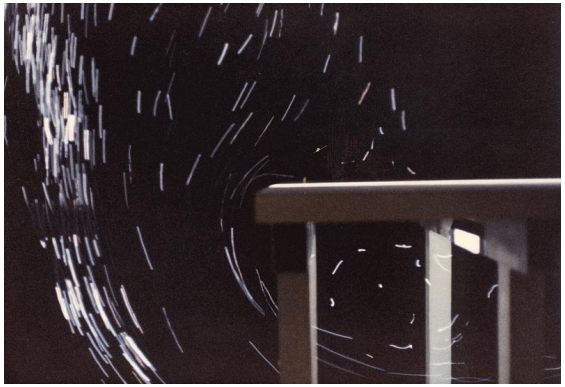
Modeling and Simulation

- **Tracer Gas Evaluations**
  - Provides “clearing time” with tracer gas rate-of-decay
  - Confirms actual air change rate effectiveness
  - ASHRAE provides guidelines

- **Neutrally-buoyant helium bubble evaluations**
  - Study and adjust airflow patterns
  - Optimize register and diffuser placement
  - Safe and simple operation



❖ **Considerations…**
  - Requires full-scale model, or existing lab

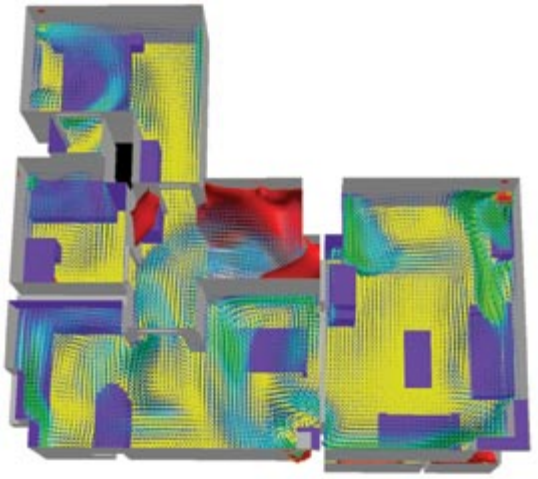


Modeling and Simulation

- **Computational Fluid Dynamics (CFD)**
  - Estimate residence time of hazard
  - Develop “answers” to spill scenarios
  - Evaluate placement of major design-elements: hoods, benches, registers
  - Examine numerous “what-if” scenarios
  - Avoid dead or “lazy” air or areas of air recirculation

❖ **Considerations…**

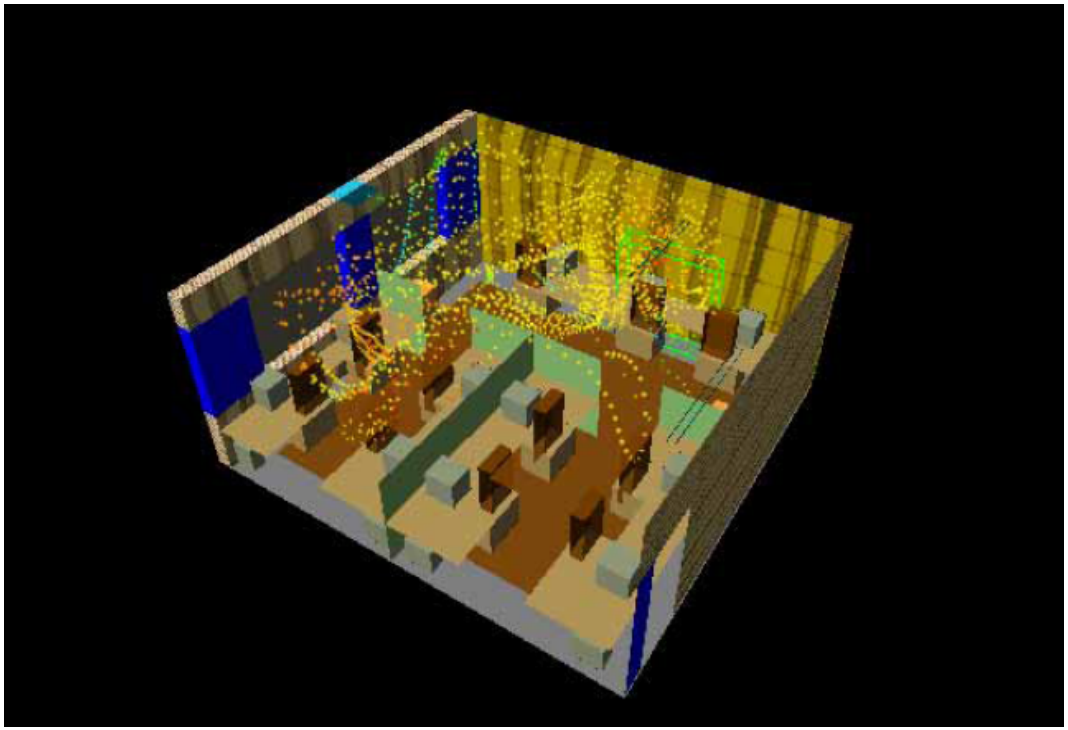
  - Use experienced modeling company



CFD Model courtesy CD-adapco

Modeling and Simulation

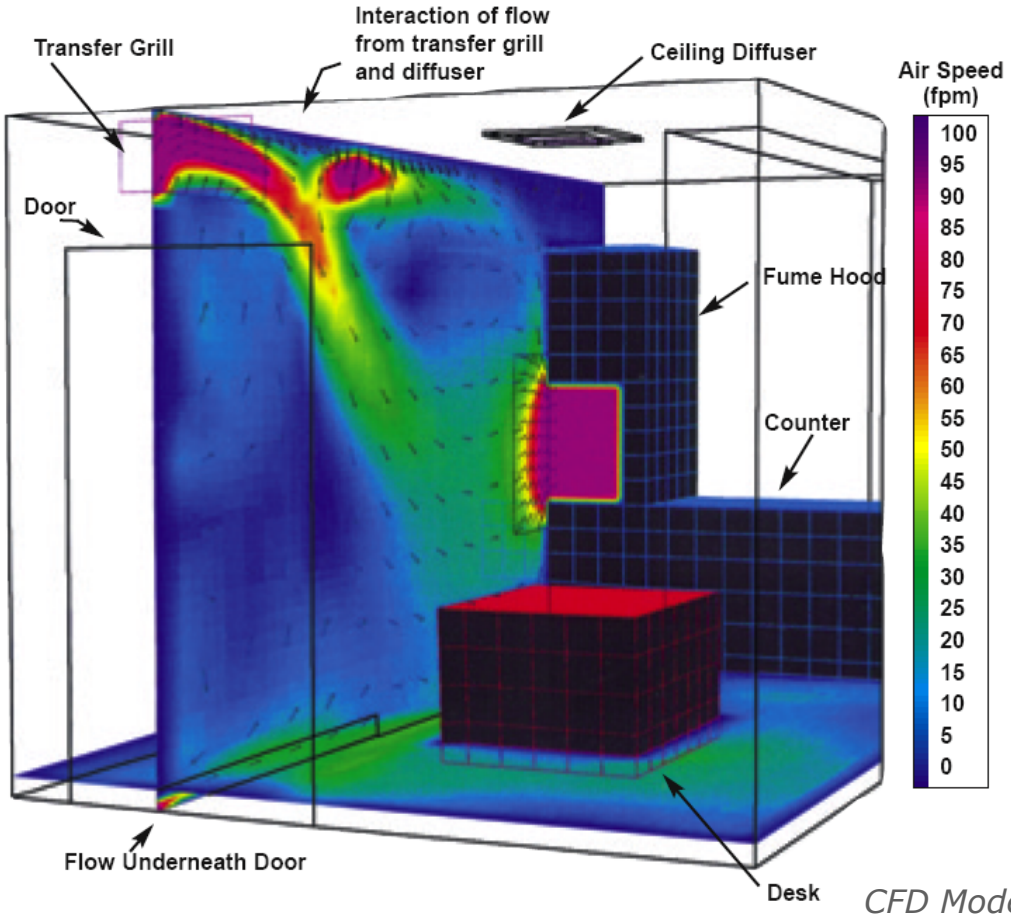
CFD Three-dimensional supply and exhaust airflow review



CFD Modeling courtesy Flow Sciences, Inc.

Modeling and Simulation

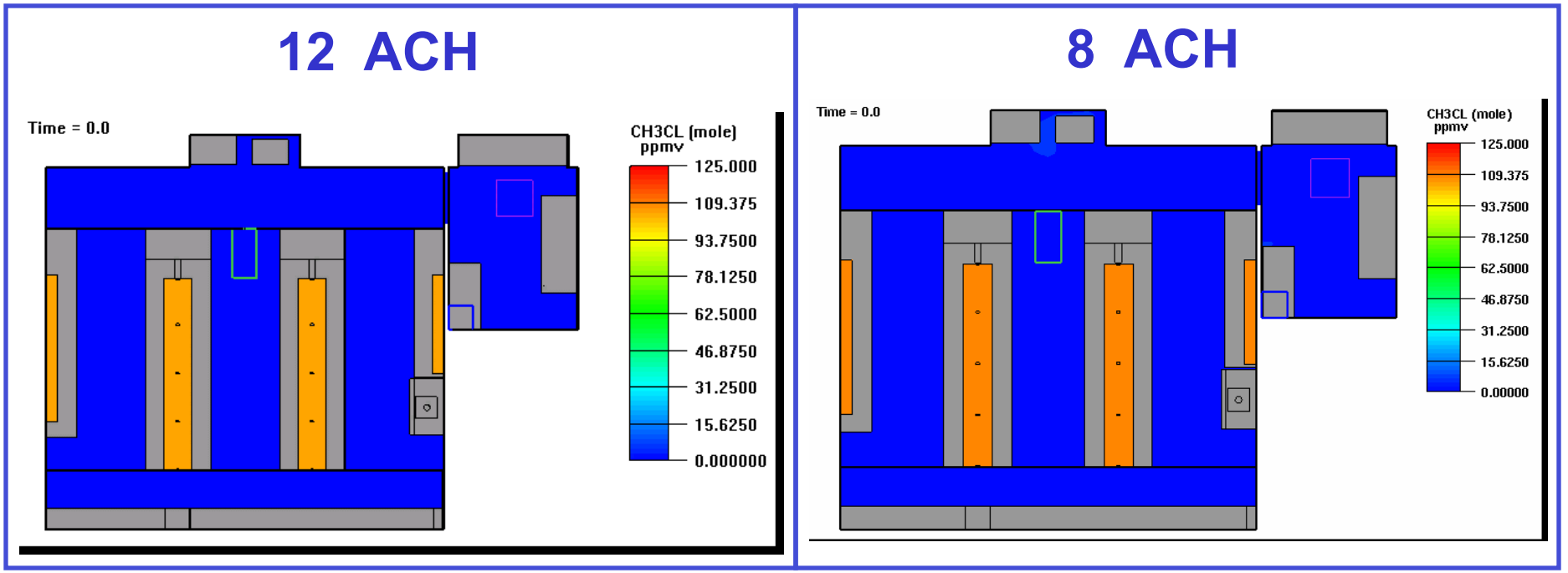
CFD two-plane supply and exhaust airflow review



CFD Modeling courtesy RWDI, Inc.

Modeling and Simulation

CFD model of pharmaceutical lab



CFD Modeling courtesy Fluent

- 1-liter liquid methyl chloride spill in isolation room
- 9 sq.ft. spill area
- Vaporization occurs over 600 seconds at constant rate

2. Scrutinize the Air Changes - Conclusions

- Ventilation effectiveness in more dependent on lab and HVAC design than air change rates (ACR)
- High ACR can have a negative impact on containment devices
- Consider:
  - cfm/sqft rather than ACR
  - Panic switch concept
  - Cascading air from clean to dirty
  - Setback ACR when lab is unoccupied
  - Demand controlled ventilation (based on monitoring of hazards and odors)

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